Sterilization and disinfection in the physician's office

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Objective: To review the principles and practice of sterilization and disinfection of medical instruments in the office setting.
Data sources: Searches of MEDLINE for articles published from 1980 to 1990 on disinfection, sterilization, cross infection, surgical instruments and iatrogenic disease, bibliographies, standard texts and reference material located in a central processing department.
Study selection: We reviewed surveys of decontamination practices in physicians' offices, reviews of current recommendations for office decontamination procedures, case reports of cross infection in offices and much of the standard reference material on decontamination theory and practice.
Data synthesis: There have been few surveys of physicians' decontamination practices and few case reports of cross infection. Office practitioners have little access to practical information on sterilization and disinfection.
Conclusion: The increasing threat of cross infection from medical instruments calls for greater knowledge about decontamination. We have adapted material from various sources and offer a primer on the subject.

Objectif : Examiner les principes et la pratique de la stérilisation et de la désinfection des instruments médicaux dans le contexte du bureau.
Sources de données : Recherches dans MEDLINE sur les articles publiés de 1980 à 1990 traitant de la désinfection, de la stérilisation, des infections nosocomiales, des instruments chirurgicaux et des maladies iatrogènes, des bibliographies, des manuels courants et des ouvrages de référence dans un service de traitement central.
Sélection d'études : Nous avons examiné des sondages sur les pratiques de décontamination dans les bureaux de médecin, des études sur les procédures actuellement recommandées pour la décontamination dans les bureaux, des exposés sur les infections nosocomiales dans les bureaux et une bonne partie des ouvrages de référence courants qui portent sur la théorie et la pratique de la décontamination.
Synthèse des données : Peu d'études ont porté sur les pratiques des médecins relatives à la décontamination et rares sont les exposés de cas sur les infections nosocomiales. Les médecins en pratique privée ont difficilement accès à des informations pratiques sur la stérilisation et la désinfection.
Conclusion : La menace croissante d'infections nosocomiales à partir des instruments médicaux exige de meilleures connaissances sur la décontamination. Nous avons adapté des textes d'origines diverses et offrons un guide traitant du sujet.

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Physicians have been decontaminating instruments used in their office practices for over a century. It is remarkable that a procedure so historic, so universal and so basic to the practice of good medicine has generated literature that could be read in one sitting. Efforts to prevent cross infection by instruments have so far focused on hospital practice. There are many reasons why we should now turn our attention to the office: (a) although office medicine is less invasive than hospital medicine its extensiveness gives ample opportunity for cross infection, (b) office staff are often undertrained and unsupervised, (c) physicians have little basic training in decontamination theory or practice, (d) office equipment for decontamination is crude and, most important, (e) office practitioners lack reference material that is concise, practical and relevant to their needs.

We review the literature and offer a short primer on the theory and practice of sterilization and disinfection in the physician's office.

Review of the literature

The lack of informative reviews on decontamination has been commented on by researchers in the very few surveys that have looked at current office practices[1-5] and by physicians participating in our provincial peer review program. Our search of MEDLINE for articles published from 1980 to 1990 turned up only two articles on the subject for dermatologists[6,7] and one for general practitioners.[8] In *A Code of Practice for Sterilisation of Instruments and Control of Cross Infection*[9] the British Medical Association has proposed standards for decontamination practice.

The literature contained few case reports of cross infection from instruments in physicians' offices; however, many cases probably go unrecognized. A review of reports in *Canada Diseases Weekly Report* published from 1986 to 1990 revealed only one case report, in which a gastroenterologist's sigmoidoscope had transmitted dysentery from one patient to the next.[10] This transmission could have gone unrecognized had the causative pathogen (*Shigella dysenteriae* type 1) not been so unusual in the community. The problem of recognition is greater for organisms that have a long latency, such as the human papilloma virus (HPV). If cross infection with HPV were to occur by way of a vaginal speculum the resulting premalignant or malignant disease of the cervix might take years to develop. Skegg and Paul[11] pointed out the paradox that our campaign to screen women for cervical neoplasia could actually propagate the disease if specula are not properly decontaminated.[12-14] By contrast, cases of hepatitis B transmission are more likely to be documented, as they have been in the case of transmission through acupuncture needles[15] and from an infected physician at the time of venepuncture or needle-prick procedures.[16] There have been many reports of cross infection in the course of eye and ear examinations.[17-22]

Basic principles and terminology

Cleaning physically removes, rather than kills, microbes and is always the first step in decontamination. Since sterilization reduces microbial counts logarithmically in time an initial reduction of the instrument's bioburden is essential. Furthermore, organic matter such as mucus, blood and pus may shield organisms from the biocidal effects of heat or chemicals.

After cleaning, decontamination takes the form of either sterilization or disinfection. Sterilization is an absolute: it kills all forms of microbial life, including the most resistant — the bacterial endospore. Disinfection is a relative term. The proportion of microbial flora killed depends on the intrinsic power of the disinfectant and the innate resistance of the microorganism. Microbes can be ranked in terms of their resistance to destruction in descending order as follows: bacterial endospore, tubercle bacillus, fungal spore, hydrophilic virus, vegetative fungus, lipophilic virus and vegetative bacterium.[23]

Sterilization is most commonly accomplished by heat, either moist or dry. Boiling water takes about 12 hours to kill spores and so is impractical. Sterilization time can be reduced to 15 minutes if the boiling point of water is raised to 121°C by an increase of 1 atmosphere (103.4 kPa) of pressure in an autoclave chamber. The same conditions can be created in a domestic pressure cooker, which is sometimes used in medical practice.[24] Moist heat delivers energy more efficiently than dry heat; consequently hot air ovens take much longer to achieve sterilization (60 minutes at 170°C or 120 minutes at 160°C). Their utility in practice is further limited by the intolerance of most wrapping materials to these temperatures.

Chemical disinfectants are ranked according to their biocidal capabilities as high, intermediate or low level.[25] High-level disinfectants act against all microbial forms, including bacterial spores, and may even sterilize if the contact time is long enough. (Boiling instruments for 5 minutes or more is a means of high-level disinfection.) Intermediate-level disinfectants can kill tubercle bacilli and everything else apart from bacterial spores and sometimes small, nonlipid viruses (e.g., enteroviruses). Low-level disinfectants cannot be relied on to kill tubercle bacilli and often fail to kill many viruses and fungi.

Antiseptics are microbicidal agents that are applied to skin and tissue, unlike disinfectants, which are used on inanimate objects.

Spaulding devised a system of classifying medical instruments according to their risk of causing cross infection and consequent need for decontamination.[25] *Critical items* penetrate skin, enter the vascular system or are introduced into sterile body tissues. Examples are surgical instruments, needles for injection, cardiac catheters and arthroscopes. They require sterilization. *Semicritical items* come into contact with intact mucous membranes. Examples are endoscopes, vaginal specula and thermometers. They need high-level disinfection. *Noncritical items* touch only unbroken skin. Examples are blood pressure cuffs, crutches and bedpans. Either intermediate-level or low-level disinfection should be used.

Sterilization

Cleaning

Immediately after instruments have been used immerse them in warm water and a detergent or detergent-disinfectant. Scrub them with a soft-bristle brush below water level to prevent aerosol formation. Rinse them. At this stage an ultrasonic cleaning bath can be used to clean the parts of the instruments that cannot be reached by scrubbing. Dry the instruments before wrapping them. Dismantle all items. Hinged instruments should be in the open, unlocked position; syringes and barrels should be separate.

Wrapping

Critical items that are not to be used immediately must be wrapped before being autoclaved. Lay the instruments on two sheets of appropriately sized wrapping material. Fold the two sheets sequentially.[26] Seal with autoclave tape — this has a chemical indicator that confirms that the pack has been processed. Date and label the pack. The standard cloth or "linen" wrap is made of muslin, which is unbleached cotton (about 22 threads/cm^2 [140 threads/in^2]) sewn around the edges to form 2-ply sheets. Muslin must be freshly laundered before each use to rehydrate the fibres. Various papers such as crepe are used for wrapping, but they puncture easily and are not water-repellent. Many single-use nonwoven wraps are available. They combine synthetic and nonsynthetic fibres (e.g., cellulose, nylon and rayon) and have excellent properties, but they are expensive.

Paper–plastic peel pouches are a simple alternative to wrapping for most small instruments; the pouches often have convenient features like a self-sealing closure and a built-in chemical indicator.

Autoclaving

Distilled water is used in the autoclave (or pressure cooker) to prevent scale formation on instruments. Arrange the items or packs so that steam can circulate and penetrate. Set the timer to 20 minutes for unwrapped items and 30 minutes for small packs. Once they are cool remove the items. If any have wet spots they must be reprocessed.

Storing

Store wrapped packs on closed shelves, not at floor level, away from drips, drains, moisture and vermin.[27] Avoid handling stored packs because this draws contaminants in through a bellows effect. Maximum durations of storage (e.g., 7 weeks for double-wrapped muslin on closed shelves) that have been recommended in the past[28] may be invalid.[29] Time does not contaminate; events do. Care in storage and handling and the use of a plastic dust cover (available commercially) may greatly extend the shelf life of a pack. Items sterilized in paper–plastic peel pouches can be stored for 1 year.

Monitoring sterilization

There are no data on which to base a recommended maintenance interval for office autoclaves. Check the pressure and temperature gauges periodically and verify the timer accuracy against a clock. Have a regular routine of using chemical or biologic indicators to monitor sterilization. Chemical indicator strips undergo a colour change when sterilizing conditions have been met. However, they are less accurate than biologic (spore) tests. Vials of *Bacillus stearothermophilus* spores are run through an autoclave cycle then grown in a small portable incubator (costing about $150) to test for viability.

Disinfection

There are two ways to disinfect instruments: heat or chemicals. Immersing cleaned instruments in boiling water for 5 minutes will accomplish high-level disinfection. For decades this has been done in doctors' offices by means of a contraption that lowers a trivet of instruments into boiling water and belches steam in the process. Sometimes referred to by the misnomer "the steam sterilizer" this machine is actually a hot-water disinfector. The water in the disinfector's bath should be changed daily before use.[30] To boil water in a pot on a heating ring would accomplish the same end.

Chemicals should be used only when heat cannot be used. Their performance may be affected by many factors. Thorough cleaning beforehand is essential, because chemicals do not disinfect in the presence of organic matter. Some chemicals are corrosive to metal. 0thers are volatile, flammable or potentially toxic to staff or patients. The properties of chemical disinfectants have been extensively reviewed elsewhere[31,32] and are briefly summarized here.

Alcohol

Alcohol is used in concentrations of 60% to 90% by volume. It does not corrode metal but may damage rubber or plastic. Ethyl alcohol is a high-level disinfectant, but it is expensive and difficult to obtain. Isopropyl alcohol is more commonly used, but because it is less effective against hydrophilic enteroviruses[23] it is an intermediate-level disinfectant. Both are active against human immunodeficiency virus (HIV) and hepatitis B virus (HBV).

Alcohol's volatility can cause several problems. If alcohol is left open to air its concentration will decline, because the alcohol component evaporates faster than the water. If it is used as a wipe the contact time may be insufficient to disinfect. The fumes may be irritating to staff members. Alcohol is flammable and must not be used with cautery or lasers.

Chlorine products

Free chlorine is a fast-acting high-level disinfectant. In clinical practice it is usually derived from sodium hypochlorite (liquid bleach) or calcium hypochlorite (tablets or granules). Like alcohol it is inactivated by organic matter. Because it corrodes metal its use has been largely restricted to the cleaning of blood spills (in a dilution of 1:10 with 5.25% household bleach).

Glutaraldehyde

Used as a 2% alkaline solution (sometimes with an added phenolic agent) glutaraldehyde is a fast-acting and noncorrosive high-level disinfectant, which makes it the ideal agent for cleaning endoscopes and some other heat-sensitive items. More general application of glutaraldehyde around the office needs caution. After long periods of immersion in glutaraldehyde (e.g., 6 to 10 hours) instruments can be rendered sterile. However, there are several reasons why such a practice should not be used as an alternative to autoclaving for heat-stable materials. During the period of immersion required for sterilization no other instrument can be introduced or removed from the bath. The instrument would then have to be rinsed with sterile water and used immediately, since there would be no means of packaging it for storage. Glutaraldehyde products are very expensive, and once mixed they remain active for only 14 to 28 days, depending on the formulation. Moreover, there are concerns about their toxicity. Staff members exposed to glutaraldehyde fumes commonly complain of eye irritation or breathing problems.[33,34]

Mixing should be done in a well-ventilated area by trained staff wearing gloves and goggles to protect against splashes.[9] Glutaraldehyde is a tissue irritant and contact sensitizer and should be rinsed off the instrument thoroughly.

Hydrogen peroxide

This inexpensive agent may prove to be a useful high-level disinfectant (or even sterilant) that remains active in the presence of organic matter, but there have been too few studies of its properties to recommend its use at this time.[23,31]

Iodophors

These agents comprise iodine and a carrier (e.g., povidone), which releases the iodine gradually. Iodophors have limited activity against *Mycobacterium tuberculosis* and hence are intermediate-level disinfectants. They are inactivated by organic matter. They must be diluted exactly as directed. Preparations formulated as antiseptics cannot be used as disinfectants.

Phenolics

These may be low-level or intermediate-level disinfectants. They are corrosive, irritating to tissue and difficult to rinse off but are useful for hospital housekeeping because they are not inactivated by organic matter. They are derivatives of phenol (also known as carbolic acid).

Quaternary ammonium compounds

The "quats" (e.g., benzalkonium chloride) are popular because they are not toxic. However, they are only low-level disinfectants and should be relegated to general clean-up duties. These compounds were formerly used as antiseptics but are no longer recommended for such use[31] because gram-negative bacteria can survive or grow in them.

Suggested decontamination procedures

Table 1 summarizes our suggestions for decon-

taminating specific instruments in the physician's office. There are many potential controversies here that await further research and discussion, and the physician should view our suggestions as tentative. Most often our choices were derived from Spaulding's rules,[25] although we also used published recommendations for specific instruments and sometimes just the law of long custom.

Consider, for instance, the case of the glass thermometer. The standard decontamination procedure still being recommended[9,31] is cleaning followed by immersion for 10 minutes in isopropyl or ethyl alcohol. Because isopropyl alcohol is an intermediate-level disinfectant and not effective against hydro-

Table 1: Suggested decontamination procedures for selected office instruments

Instrument or item	Category*[25]	Decontamination level†		Procedure
		Optimal	Minimal	
Surgical instruments	C	St	St	Sterilize with heat (in autoclave or hot-air oven); chemical sterilization not recommended
Needle and syringe	C	St	St	Sterilize with heat; disposables preferred
Acupuncture needle	C	St	St	Sterilize with heat; disposables preferred
Neurologic test pin	C	St	HLD	Sterilize with heat, boil, immerse in 1:10 bleach solution or glutaraldehyde, or use disposables
Stitch cutter	C	St	HLD	Sterilize with heat, boil, immerse in glutaraldehyde or use disposables
Electrocautery tip for use on skin	C	St	HLD	Sterilize with heat; boiling or HLD kills hepatitis B and human immunodeficiency viruses
Vaginal speculum (metal) and tenaculum for intrauterine device insertion	C	St	St	Sterilize with heat
Vaginal speculum (e.g., for Papanicolaou smear)	SC	HLD	HLD	Autoclave, boil for 5 minutes or immerse in glutaraldehyde (rinse well)
Pessary and diaphragm fitting ring	SC	HLD	HLD	Boil for 5 minutes or immerse in glutaraldehyde (rinse well)
Nasal speculum	SC	HLD	HLD	Sterilize, boil or immerse in glutaraldehyde or 1:10 bleach
Tonometer footplate	SC	HLD	HLD	Immerse in 1:100 bleach for 10 minutes
Rigid sigmoidoscope and proctoscope	SC	HLD	HLD	Sterilize, boil or immerse in glutaraldehyde for 20 minutes
Fibreoptic sigmoidoscope and laryngoscope	SC	HLD	HLD	Clean and disinfect all channels carefully; immerse in 2% glutaraldehyde for 20 minutes
Thermometer (glass)	SC	HLD	HLD	Immerse in 60% to 90% ethyl alcohol for 10 minutes or glutaraldehyde (rinse well); consider disposables or sheaths
Laryngeal mirror	SC	HLD	HLD	Sterilize with heat, boil or immerse in glutaraldehyde
Ear suction tip	SC	HLD	HLD	Sterilize with heat, boil or immerse in glutaraldehyde
Ear speculum and ear syringe nozzle	SC	HLD	HLD	Sterilize with heat, boil or immerse in glutaraldehyde, chlorine (if plastic), iodophor or alcohol
Stethoscope	NC	ILD	LLD	Immerse in alcohol, a phenolic or quaternary ammonium compound (quat)
Examining table, counter tops, baby scales	NC	ILD	LLD	Use a phenolic or quat; if fecally contaminated, phenolic preferred; if blood contaminated, use 1:10 bleach solution

*C = critical item, SC = semicritical item, NC = noncritical item.
†St = sterilization, HLD = high-level disinfection, ILD = intermediate-level disinfection, LLD = low-level disinfection.

philic viruses (e.g., coxsackievirus and echovirus) this habit seems unwise on theoretic grounds. Recommendations made elsewhere include immersion in tincture of iodine or glutaraldehyde[26] and then copious rinsing. An alternative approach would be to continue the use of isopropyl alcohol and cover the thermometer with a disposable polyethylene sheath.

Another dilemma is the correct way to decontaminate electrocautery needles. Sherertz and associates[35] experimentally debunked the myth of self-sterilization by showing that HBV survived simulated use.[35] If electrocautery needles were used for hemostasis of open wounds full sterilization would certainly be called for. Since those needles are also used for electrodesiccation of intact lesions we have allowed for the option of boiling or of a chemical high-level disinfectant to kill all pathogenic viruses and vegetative bacteria.

The practice of using alcohol to clean tonometers and other eye instruments is at odds with theory and experience. There have been many reports of outbreaks of epidemic keratoconjunctivitis resulting from eye examinations.[17-20] Nagington, Sutehall and Whipp[36] showed that herpes simplex virus type 1 and adenovirus 8, the causative agent of epidemic keratoconjunctivitis, were killed after a 10-minute immersion in a hypochlorite solution (500 parts per million) but not in alcohol.

Specific decontamination procedures for endoscopes have been proposed, but compliance with them may be poor. Katner and colleagues[37] surveyed US family physicians performing proctosigmoidoscopy in their offices and found a significant number using inadequate or questionable decontamination procedures. The proper procedure requires thorough cleaning with water and detergent to remove organic matter from all exterior and interior surfaces. A brush is used to clean the suction or biopsy channel of flexible endoscopes. The endoscope should then be immersed in 2% alkaline glutaraldehyde and any channels disinfected by means of injection or suction. The endoscope should be rinsed thoroughly. The Working Party of the British Society of Gastroenterology recommended in 1987 that a 4-minute immersion in glutaraldehyde be used,[38] but the 1990 guidelines of the Association for Practitioners in Infection Control have called for an increase in the exposure time to 20 minutes.[31] Since glutaraldehyde is slow to kill *M. tuberculosis* the longer immersion time is particularly important for bronchoscopes[31,39] or for the fibreoptic laryngoscopes now commonly used in ear, nose and throat practices.

Fingerstick devices used with glucose meters have recently caused cross infection with HBV.[40] Such devices may have two disposable components: the lancet and the stage, which stabilizes the fingertip. Cross infection occurred when only the lancet was changed between patients.[40] If the stage is not disposed of it should at least be subjected to high-level disinfection (e.g., with a 1:10 dilution of household bleach) before use on each patient.

Multidose medication vials are another potential vehicle for cross infection. In one study vials of local anesthetic in an outpatient department were opened and centrifuged. The sediment contained erythrocytes and other organic debris.[41] If more local anesthetic is needed during a procedure both a fresh syringe and a fresh needle should be used to avoid the regurgitation of blood into the vial.

Conclusions

As if to prove that good can come from bad the current epidemic of HIV infection has caused us to re-examine our office decontamination procedures. Our deficiencies can largely be attributed to the lack of available reference material relevant to office needs. Since the physician may be unable to find a recommendation in the literature for any given sterilization or disinfection need an understanding of Spaulding's[25] system is essential.

The importance of thoroughly cleaning instruments before sterilization or disinfection cannot be overemphasized. An autoclave is the best way to sterilize instruments and should be standard equipment in any office in which critical items are used. Chemical sterilization should be reserved for items that cannot be heat-processed. Chemical disinfectants are essential to office practice, but the agent must be matched to the task. The ideal disinfectant has not yet been found. Each agent in current use is limited by its microbicidal spectrum, corrosiveness, inactivation by organic matter or toxicity. Good decontamination practice should not be left to chance. We suggest a training session for each staff member and a written procedure manual for reference. Finally, it is the physician's responsibility to ensure that staff members are protected from exposure to noxious substances and injury by sharp instruments.

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